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GB A 2179886 GB 1596067 GB 1090785
EP A 0039201

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B5A
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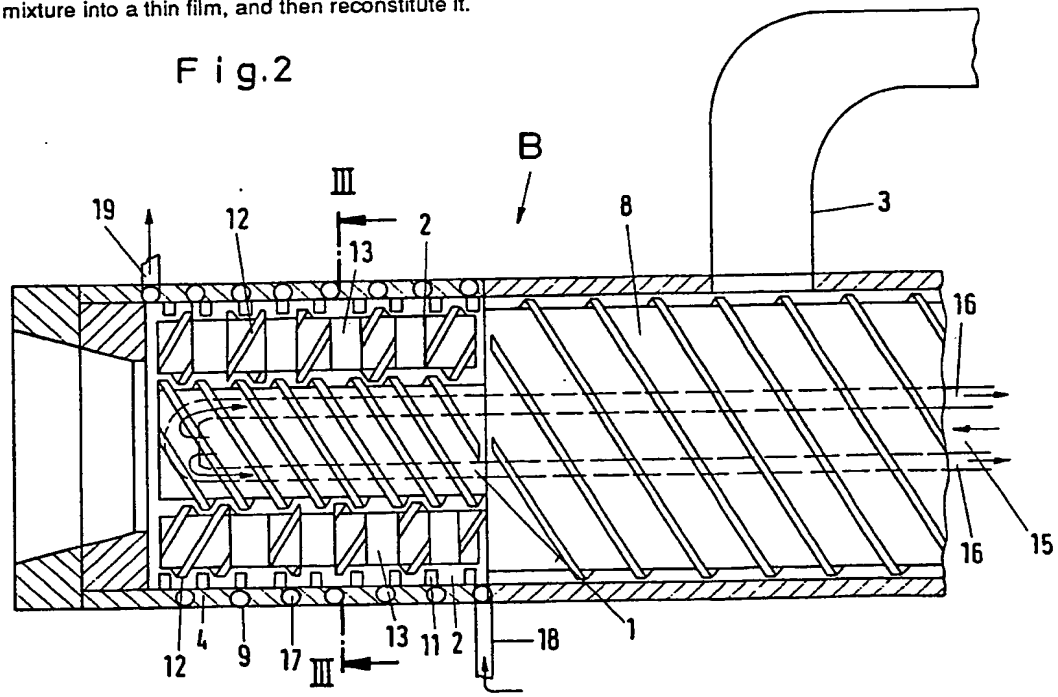
B29C B29F

(54) A method and apparatus for producing foamed tubes of plastics materials

(57) A first extruder (A, Fig 1) produces a fused mass of a mixture of the plastics material and foaming propellant, and feeds it under pressure at inlet (3) into a second extruder (B) comprising a housing (4) having internal helical toothing (11), a central spindle (1) having external helical toothing, and a plurality of planetary spindles (2) having untoothed regions (13), between toothed regions (12) which mesh with both the housing and central spindle toothing, cooling means (15, 16, 17) being provided for cooling the mixture as it passes through the extrusion device (B) e.g. via a gear pump, to a discharge nozzle (21) for discharging the material as a tube. The pressure feed into the extruder (B) avoids foaming of the mixture during the enhanced cooling, effected in the extruder (B) by the toothed and untoothed regions (12, 13) which repeatedly roll the mixture into a thin film, and then reconstitute it.

Fig.2



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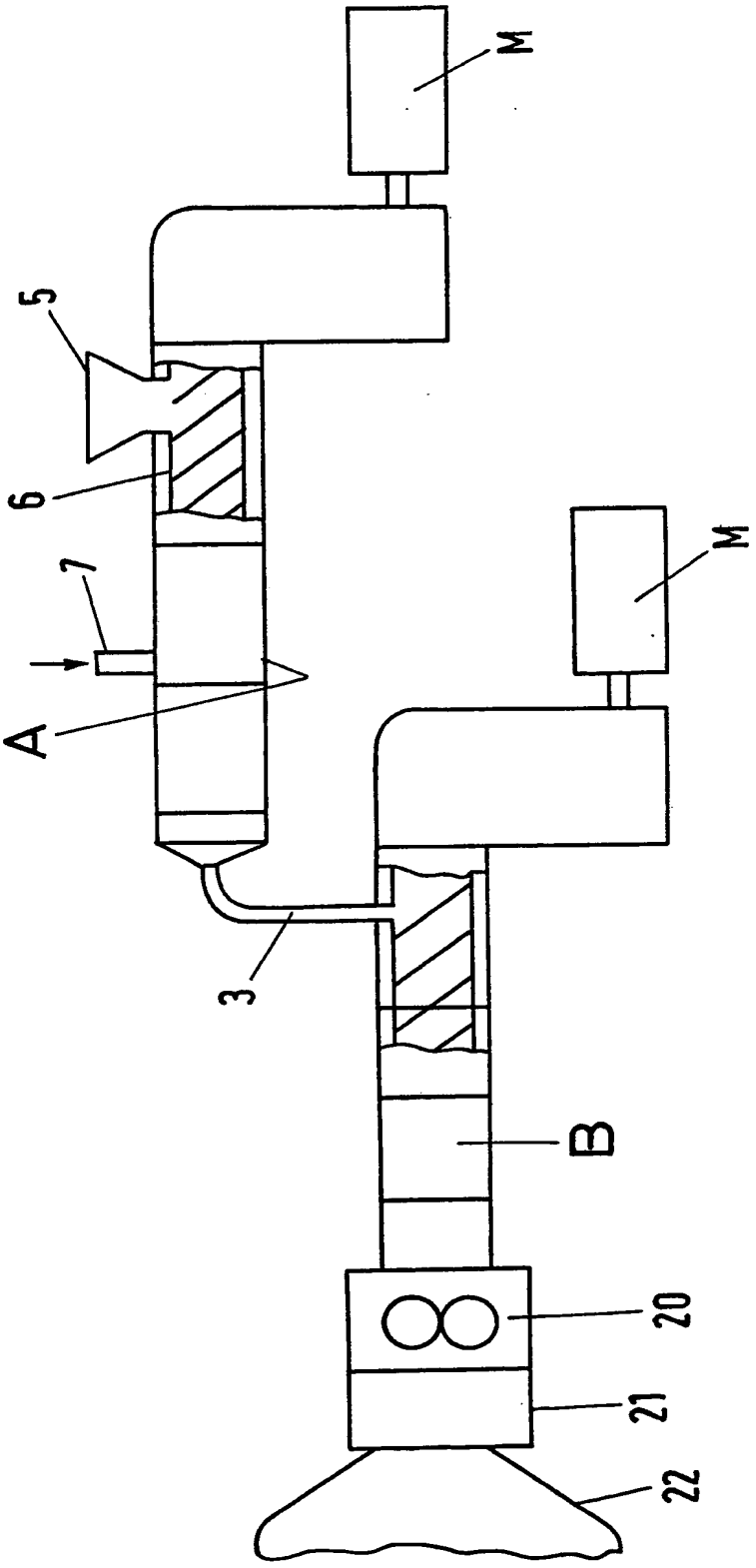


Fig.1

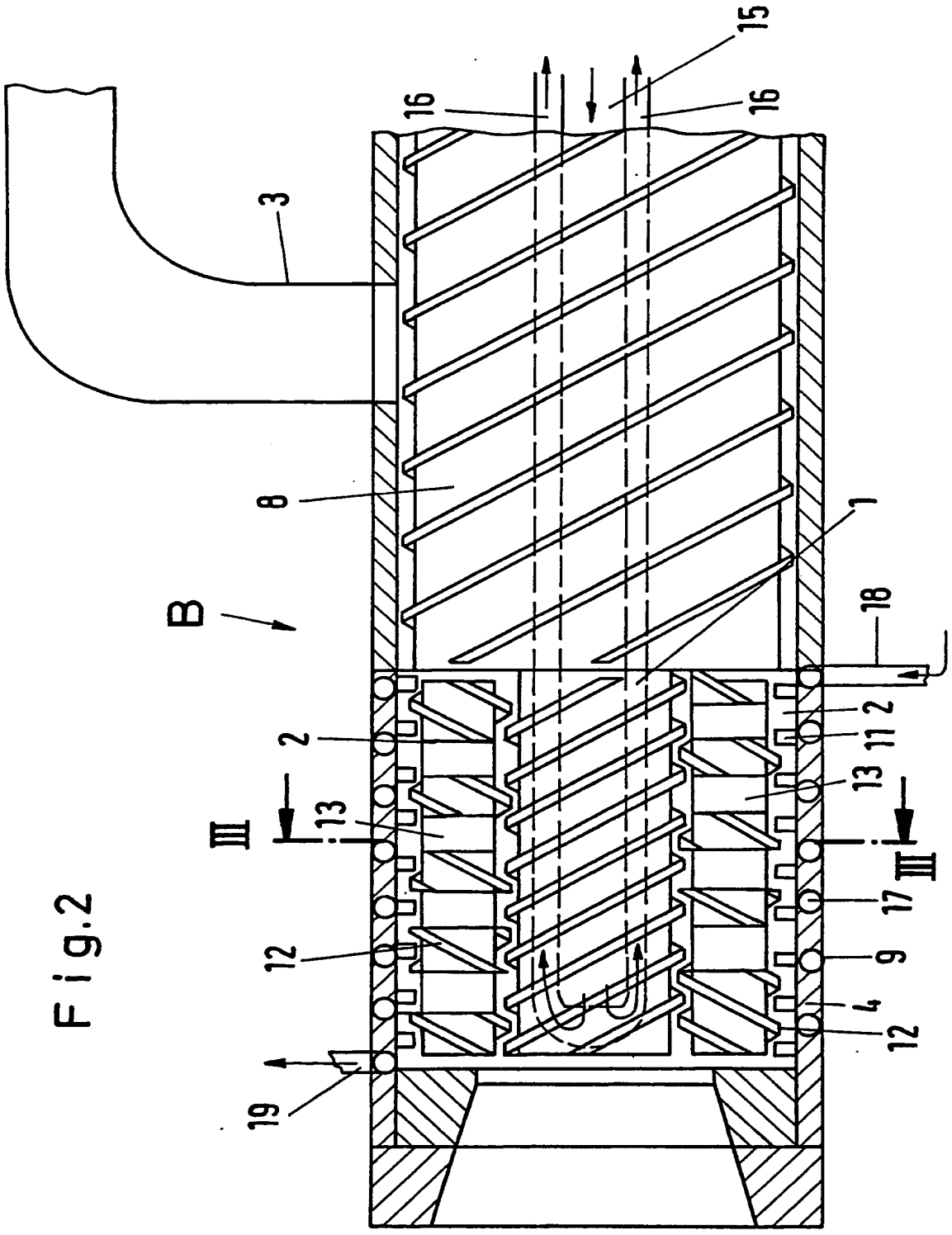
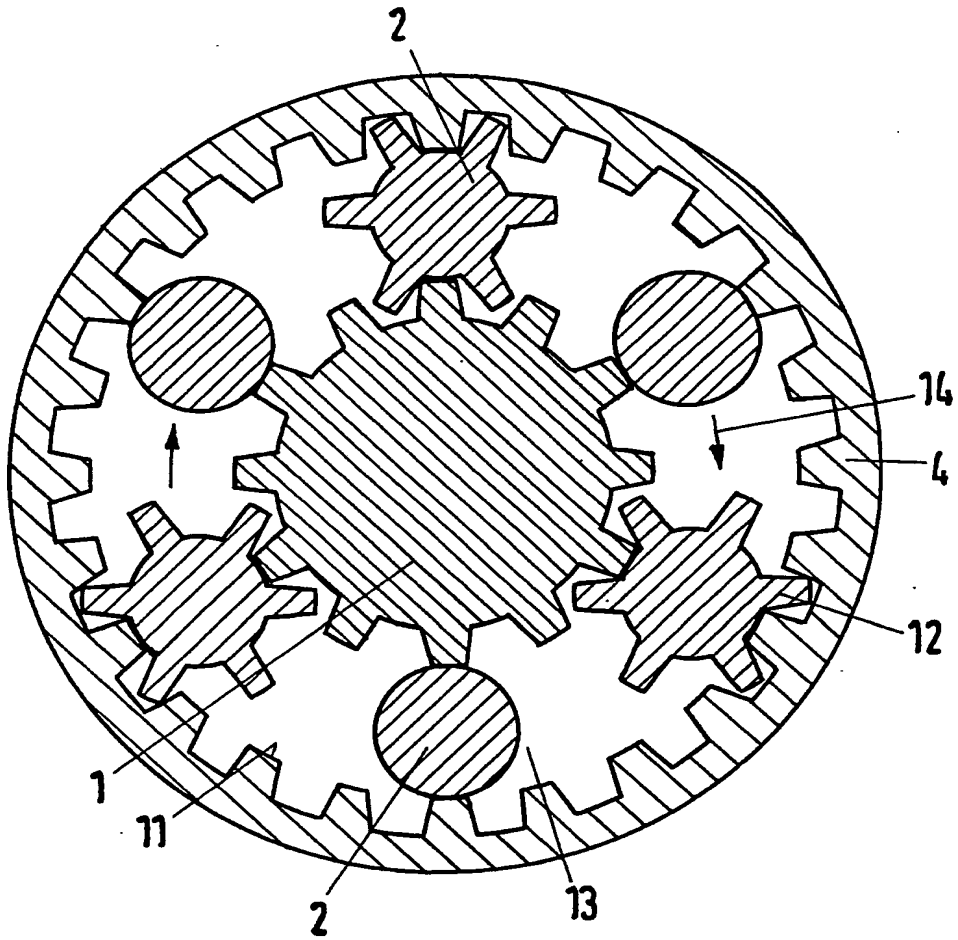


Fig.2

Fig.3



TITLE OF THE INVENTION

"A method and apparatus for producing foamed tubes of plastics materials"

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for producing foamed tubes of plastics material and, more particularly, to a method and apparatus for producing such tubes by extrusion.

BACKGROUND OF THE INVENTION AND PRIOR ART DISCUSSION

In German Auslegeschrift No. 1 135 652, there is disclosed an apparatus for producing a molten mixture of a plastics material and a propellant. Such apparatus comprises a primary extrusion device for fusing the plastics material, such as polystyrene, and for mixing the fused material with a propellant such as Freon (Registered Trade Mark). The mixture of fused polystyrene and propellant is subsequently transferred into a secondary extrusion device wherein the fused mass is cooled. In the secondary extrusion device, the mixture of the fused mass of polystyrene and propellant must be cooled to a temperature below the critical temperature of the normally gaseous propellant and is then extruded to form a tubular film.

The secondary extrusion device shown in this prior German Auslegeschrift comprises a cooled shaft having vanes or fins disposed thereon in a paddle-like manner. The housing of the secondary extrusion device is also cooled. However, when such a secondary extrusion device is utilised, it is found that the fused mass predominantly rotates together with

the central shaft and with the vanes or fins. Accordingly, such an arrangement does not assist in achieving the desired rolling-out of the mixture within the secondary device to form a film. Such apparatuses therefore prove disadvantageous because of the lack of appropriate conveying of the fused mixture.

It is necessary, in such an arrangement, to force the fused mixture produced by the primary extrusion device through the secondary extrusion device and also through a discharge nozzle, which pressure is produced by the primary extrusion device. The feed pressure necessary to achieve this causes a considerable amount of shearing energy to be introduced into the fused mixture. In consequence, the temperature in the secondary extrusion device increases.

A large amount of external energy is required to produce the intensive cooling necessary to compensate for this increase in temperature. Polystyrene, for example, is a very poor conductor of heat. Since the secondary extrusion device shown and described in this prior specification only brings about a poor cooling effect because of its mode of operation, and since shearing heat is also introduced into the fused mixture, it is necessary for the cooling surfaces to be as large as possible. Accordingly, the secondary extrusion device must be very long to achieve a viable cooling effect. However, as the length of the extrusion device is increased, the feed pressure of the primary extrusion device needs to be correspondingly greater to achieve transfer of the material into the secondary extrusion device and to permit tubular film to be extruded. This additional length causes more shearing energy to be introduced into the fused material.

In German Offenlegungsschrift No. 2 719 095, there is disclosed an extrusion device having planetary spindles disposed around a central spindle and in which the helical toothing provided on the planetary screws are discontinuous. Such an extrusion device is generally used for homogenising mixtures.

The prior document does not disclose, or even contemplate, the use of such an extrusion device for cooling a fused mixture such as a mixture of polystyrene and a propellant. In fact, such a device will not, under normal circumstances, provide a cooling effect on mixtures passing therethrough.

When a fused mixture of polystyrene and a propellant is being processed, it is necessary for the mass to be cooled to below the critical temperature of the normally gaseous propellant, whilst still maintaining the high pressure required for the extrusion of a tube of material. The pressure has to be maintained at a high level to prevent the mixture in the discharge head from foaming prematurely. A problem does, however, arise in that the cooling must be effected whilst maintaining the pressure and that shearing heat must not be introduced into the mixture. It will be readily appreciated that these desiderata are usually considered to be incompatible with one another.

OBJECT OF THE INVENTION

The present invention seeks to provide a method and apparatus for extruding a foamed tube formed from a fused mixture of a plastics material and a propellant in which the mixture is maintained at an elevated pressure and is also cooled whilst such extrusion is taking place without, however,

the extrusion causing the introduction of shearing energy into the material.

BRIEF SUMMARY OF THE INVENTION

According to the present invention there is provided a method of producing a foamed tube from a plastics material and a propellant comprising the steps of forming a fused mixture of the plastics material and propellant in a first extrusion device, feeding the mixture at an elevated pressure into a second extrusion device, subjecting the mixture to repeated rolling into a thin film and then reconstitution in the second extrusion device such that the pressure is substantially maintained whilst shearing energy introduced into the material by the extrusion device is minimised, cooling the mixture as it passes through the extrusion device and extruding the mixture through a nozzle in the form of a thin tube and permitting the mixture to foam once it has passed through the nozzle.

Also according to the present invention there is provided an apparatus for producing a foamed tube from a plastics material and a propellant comprising a first extrusion device for producing a fused mass of the plastics material and propellant and a second extrusion device receiving the fused mass, the second extrusion device including a housing have a helical toothing disposed around its internal surface, a central spindle axially disposed within the housing and carrying a helical toothing around its external surface and a plurality of planetary spindles disposed within the housing around the central spindle, each planetary spindle having a discontinuous toothing on its external surface which meshes with both the toothing on the internal wall of the housing and the toothing on the central spindle and cooling means for cooling the mixture as it passes through the extrusion device, and a discharge nozzle for discharging the thus-treated material in the form of a tube.

As a result of the feed of the fused mixture being at a lower pressure than would otherwise be necessary, and due

to the constant, rolling and reconstitution of the fused mass, effective cooling can be achieved in a short component part.

BRIEF DESCRIPTION OF THE DRAWINGS

One embodiment of an apparatus in accordance with the present invention will be further described, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic view of an extrusion system comprising two extrusion devices in series which is used for producing a fused mixture of polystyrene and a propellant.

Fig. 2 is a detailed, schematic side elevational view, partially in section, of the second of the two extrusion devices shown in Fig. 1.

Fig. 3 is a cross-sectional view taken along the line III-III of Fig. 2.

DESCRIPTION OF PREFERRED EMBODIMENT

In Fig. 1, there is shown an extrusion system suitable for extruding polystyrene foam which comprises a primary extrusion device A and a secondary extrusion device B in series with one another.

The polystyrene to be expanded is, initially, in granular form, is metered into feed hopper 5 of the primary extrusion device A and is fused therein by means of an extrusion screw 6. A high pressure, which may be as high as 200 bars is built-up in the primary extrusion device A. A propellant, such as Freon, is then injected into the primary extrusion device A at a pressure slightly in excess of that

of the fused polystyrene by means of a propellant injection conduit 7. The propellant is homogeneously mixed with the fused mass of polystyrene.

The mixture of material and propellant is advanced without any appreciable pressure reduction. Such a pressure reduction would actually lead to an expansion or foaming of the polystyrene in the primary extrusion device A. Subsequently, the mixture of material and propellant is fed through a conduit 3 into the secondary extrusion device 8. In such device, the mixture must be cooled, without the pressure in such extrusion device being allowed to fall below a predetermined pressure. If such a pressure drop occurred, premature foaming would occur. The cooling is necessary to ensure that the cell walls do not burst during the foaming process, that is to say, as the fused mass emerges from the discharge head.

To effect a cooling process, the material is fed into a secondary extrusion device B which has a relatively short overall length. If desired, the material may be made to pass through a conventional screw section 8 prior to entering the secondary extrusion device B. If no section 8 is present the fused mass of material and propellant is fed directly into a cooled portion 9 of a planetary extruder.

The cooled portion 9 of the planetary extruder comprises a central spindle 1 and planetary spindles 2 which co-operate with one another in the interior of a housing 4. The internal wall of the housing 4 is provided with a helical toothing 11.

The central spindle 1 has a cooling duct 15 extending longitudinally therethrough for the passage of a coolant from the inlet to the outlet of the portion B. Extending coaxially

with the duct 15 is a further duct 16 for the return passage of the coolant from the outlet to the inlet. The screw 1 is therefore cooled in a highly effective manner. The housing 4 is additionally provided with circumferential cooling ducts 17 which communicate with an inlet conduit 18 for coolant and with an outlet conduit 19 to permit a continuous throughflow of coolant through the ducts 17. The planetary spindles 2 each have a discontinuous helical toothing 12 formed on their external surface, the toothed and toothing-free sections 13 alternating with one another, as can be seen in the cross-sectional view shown in Fig. 3.

Additionally, in the circumferential direction of the planetary spindles 2, as shown by the arrow 14 in Fig. 3, the flight-free- that is to say, roller-like sections 13 also alternate with the toothed sections 12. Accordingly, the feed mixture of material and propellant passes between component parts which roll against one another. The action of the planetary extruder is to homogenise the mixture and to roll it out into thin layers. The provision of the untoothed portions permits the mixture to expand prior to being re-homogenised and re-rolled. Both such steps are therefore effected as the mixture passes through the extruder and this brings an optimum amount of the mixture into contact with the cooled central spindle and the cooled housing. This obviously optimises the efficiency of the cooling process. Moreover, such action also minimises the shearing energy introduced into the mixture.

Such a reconstitution process is achieved very effectively in the cooling portion 9 of the planetary extruder. The provision of the toothing-free portions on the planetary spindles permits the fused mixture to expand in these regions. In this expansion phase, the fused mass comes into contact

with the cooled housing 4 and the cooled central spindle 1, whereby the cooling process is continued. Moreover, no shearing stress is exerted on the fused mixture until the fused mixture comes into contact with the next toothed portion 12 of a spindle. However, even in the toothed regions the shearing stress exerted on the fused mixture is minimal.

The impact on the fused mixture with the toothed regions causes intensive cooling of the mixture because the fused mixture is rolled into thin layers. Subsequently, the renewed, expansion and cooling occur in the next toothing-free region 13.

The fused mixture is thus cooled in a short space of time and can be collected by a geared pump 20 and discharged, at the required pressure, in the form of a tube 22 by means of a discharge nozzle 21. The tube is no longer subject to the high pressure subsisting in the interior of the extrusion device B and, accordingly, foaming of the tube occurs naturally.

CLAIMS

1. A method of producing a foamed tube from a plastics material and a propellant comprising the steps of forming a fused mixture of theplastics material and propellant in a first extrusion device, feeding the mixture at an elevated pressure into a second extrusion device, subjecting the mixture to repeated rolling into a thin film and then reconstitution in the second extrusion device such that the pressure is substantially maintained whilst shearing energy introduced into the material by the extrusion device is minimised, cooling the mixture as it passes through the extrusion device and discharging the extruded mixture through a nozzle in the form of a tube and permitting the mixture to foam once it has passed through the nozzle.

2. A method as claimed in claim 1 wherein the plastics material is polystyrene.

3. A method as claimed in claim 1 substantially as hereinbefore described.

4. An apparatus for producing a foamed tube from a plastics material and a propellant comprising a first extrusion for producing a fused mass of the plastics material and propellant and a second extrusion device receiving the fused mass, the second extrusion device including a housing having a helical toothing disposed around its internal surface, a central spindle axially disposed within the housing and carrying a helical toothing around its external surface and a plurality of planetary spindles disposed within the housing around the central spindle, each planetary spindle having a discontinuous toothing on its external surface which meshes with both the toothing on the internal wall of the housing and the toothing on the central spindle, cooling means for cooling

the mixture as it passes through the extrusion device and a discharge nozzle arrangement for discharging the thus-treated material in the form of a tube.

5. An apparatus as claimed in claim 4, wherein the cooling means comprises a bore arrangement formed in the central spindle for permitting the flow of a coolant medium therethrough.

6. An apparatus as claimed in claim 4 or 5 wherein the cooling means comprises a bore arrangement formed in or on the wall of the housing for permitting the flow of a coolant medium therethrough.

7. An apparatus as claimed in claim 4 constructed and arranged to operate substantially as hereinbefore described with reference to the accompanying drawings.

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